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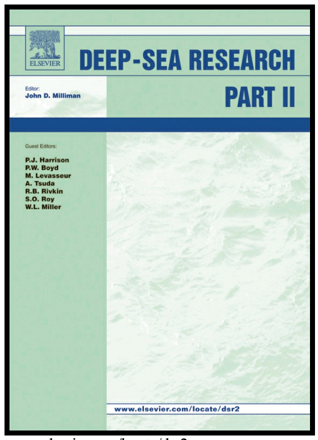

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Ocean acidification and calcium carbonate saturation states in the coastal zone of the West Antarctic Peninsula

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Abstract

The polar oceans are particularly vulnerable to ocean acidification; the lowering of seawater pH and carbonate mineral saturation states due to uptake of atmospheric carbon dioxide (CO_2). High spatial variability in surface water pH and saturation states (Ω) for two biologically-important calcium carbonate minerals calcite and aragonite was observed in Ryder Bay, in the coastal sea-ice zone of the West Antarctic Peninsula. Glacial meltwater and melting sea ice stratified the water column and facilitated the development of large phytoplankton blooms and subsequent strong uptake of atmospheric CO_2 of up to 55 mmol m^{-2} day^{-1} during austral summer. Concurrent high pH (8.48) and calcium carbonate mineral supersaturation (Ωaragonite ~3.1) occurred in the meltwater-influenced surface ocean. Biologically-induced increases in calcium carbonate mineral saturation states counteracted any effects of carbonate ion dilution. Accumulation of CO_2 through remineralisation of additional organic matter from productive coastal waters lowered the pH (7.84) and caused deep-water corrosivity (Ωaragonite ~0.9) in regions impacted by Circumpolar Deep Water. Episodic mixing events enabled CO_2-rich subsurface water to become entrained into the surface and eroded seasonal stratification to lower surface water pH (8.21) and saturation states (Ωaragonite ~1.8) relative to all surface waters across Ryder Bay. Uptake of atmospheric CO_2 of 28 mmol m^{-2} day^{-1} in regions of vertical mixing may enhance the susceptibility of the surface layer to future ocean acidification in dynamic coastal environments. Spatially-resolved studies are essential to elucidate the natural variability in carbonate chemistry in order to better understand and predict carbon cycling and the response of marine organisms to future ocean acidification in the Antarctic coastal zone.